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Geastrum reinkingii reconsidered

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ABSTRACT—Morphological studies based on type specimens revealed that *G. reinkingii* (originally described from Honduras, but subsequently synonymized under *G. lloydianum*) is a good species that is probably well distributed in tropical and subtropical forests in America. Here we present a modern description and color photographs of the species, and a comparison with the morphologically closest South American species: *G. glaucescens*, *G. hariotii*, *G. lloydianum*, and *G. setiferum*.

KEY WORDS—Agaricomycetes, earthstar fungi, gasteromycetes, *Geastraceae*, Neotropical mycota

Introduction

Geastrum Pers. is a widespread genus with numerous taxonomical problems. Many authentic species have been treated as synonyms (Trierveiler-Pereira & Silveira 2012, Zamora et al. 2014); and sometimes different species have been identified under a single name (e.g., in *G. fimbriatum* Fr.) due to a lack of differentiating morphological characters (Kasuya et al. 2012).

Several *Geastrum* species collected in tropical and subtropical areas of America were described by C.G. Lloyd, who during many years received specimens from contributors. The type specimen of *G. reinkingii* was collected in 1923 in Honduras (Central America). Its original publication (Lloyd 1924) does not include a full description of the specimen, but instead, briefly differentiates it from *G. hariotii* Lloyd. Later, the name also appeared, with no additional information, in Rick's posthumous list of the gasteroid species found

in southern Brazil (Rick 1961). Finally, the species was considered a synonym of *G. lloydianum* Rick by Ponce de León (1968) in his revision of the family *Gaeastraceae*.

Recent morphological studies based on *Gaeastrum* type specimens revealed that *G. reinkingii* is distinct from *G. lloydianum* and should be considered an authentic species.

Materials & methods

In order to better circumscribe the species, recently collected specimens and vouchers from herbaria BPI, ICN, LPS, PACA (Fungi Rickiani), and URM (Thiers 2016) were examined macro- and microscopically. Macroscopic characters were described based on observations of fresh and dried material, according to Sunhede (1989). Colors and measurements refer to dry material unless otherwise stated. Colors of macroscopic structures were determined according to Kornerup & Wanscher (1978). Colors of microscopic features were defined in KOH preparation.

Observations of microscopic characters were made under a light microscope on glass slide mounts (in 5% KOH) prepared from dried specimens. Scanning electronic microscopy (SEM) was conducted at 'Centro de Microscopia Eletrônica', UFRGS. Basidiospores were coated with 15 nm of gold using a Bal-Tec SCD050 sputter coater and photographed with a JEOL JSM-5800 scanning electron microscope.

Taxonomy

Gaeastrum reinkingii Lloyd, Mycol. Writings 7: 1280. 1924 [as "*Geaster*"]. PL. 1

BASIDIOMATA 2.0–3.4 cm high when expanded. EXOPERIDIUM non-hygroscopic, 1.4–2.7 cm high × 2.8–4.2 cm broad, split into 6–8 rays, some ramifying at the tip, arched; mycelial layer pale yellow (1A3), usually peeling off at maturity, if persistent, encrusted with debris; fleshy layer usually not persistent, pale orange (5A3) to brownish orange (5C3) when fresh, then yellowish brown (5D5) to brown (6E5) when dry; fibrous layer brownish orange (5C5) to light brown (5D4). ENDOPERIDIUM subglobose to globose when recently exposed, then depressed globose to ellipsoid, 0.5–1.2 cm high (not including the peristome) × 1.4–2.0 cm broad, yellowish brown (5E4) to grayish brown (5E3, 6E3), when fresh, then yellowish brown (5D4) to dark brown (6F3) when dry, stalked; stalk short, up to 1.0 mm high, cylindrical or flattened, dark blond (5D4) to yellowish brown (5D5), endoperidial surface asperulate to rough due to the presence of conical fascicles of hyphae (most easily observed at the base of the endoperidium, near the apophysis); apophysis beige (4B3) to yellowish brown (5D5); peristome deeply sulcate, usually strongly delimited, up to 0.45 cm high, concolor or slightly darker than endoperidium, almost black in some specimens. GLEBA pulverulent at maturity, dark brown (6F4).

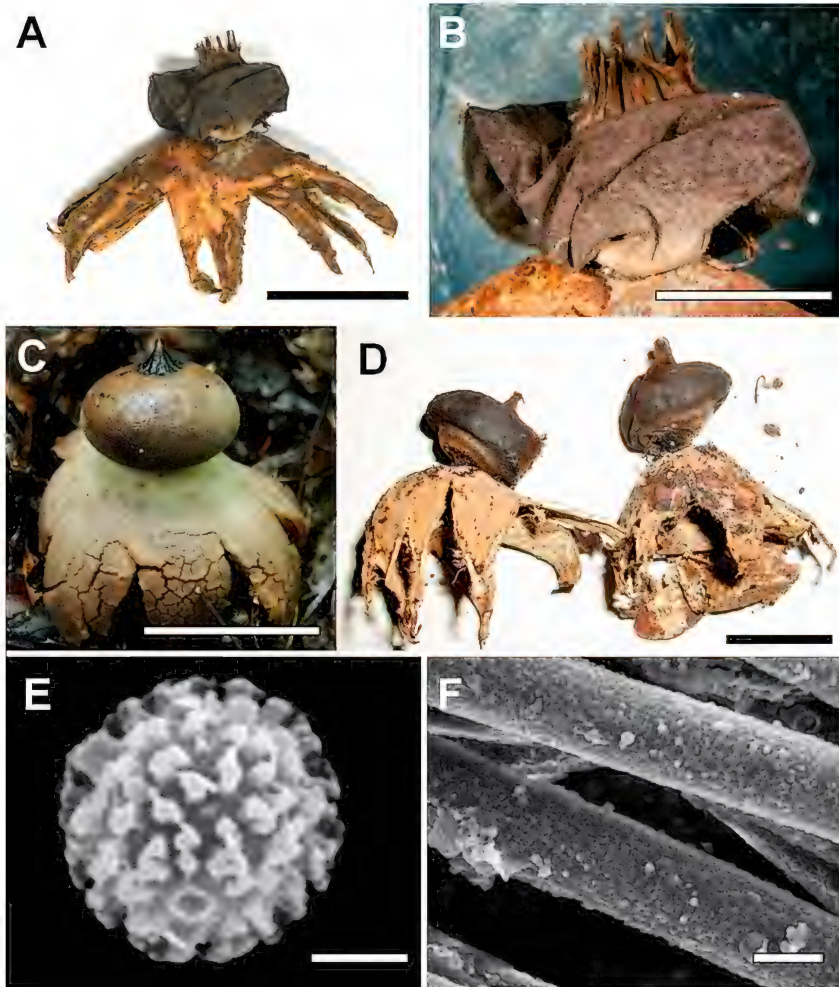


PLATE 1. *Geastrum reinkingii*. A. Holotype (BPI705664). B. Detail of the endoperidium (holotype). C. Fresh basidiome (ICN 177057). D. Dried specimens (URM 82017). E. Basidiospore (from the holotype). F. Capillitial hyphae (from the holotype). Scale bars: A, C, D = 2 cm; B = 1 cm; E = 1 μ m; F = 2.5 μ m.

CAPILLITIAL HYPHAE ≤ 8 μ m wide, pale yellow, brown to golden brown, straight, not branched, thick-walled with narrow lumen, tips round, with or without encrusted material. BASIDIOSPORES globose, 3.5–4.5 μ m in diam. (including ornamentation), brown to dark brown, ornamented with short

columns, some confluent; basidia not seen. HYPHAE OF THE MYCELIAL LAYER $\leq 3 \mu\text{m}$ wide, hyaline to pale yellowish, thick-walled; hyphae of the fibrous layer $3\text{--}11 \mu\text{m}$ wide, yellowish to pale brown, thick-walled to solid; HYPHAE OF THE PSEUDOPARENCHYMATOUS LAYER globose to ellipsoid, $\leq 74 \mu\text{m}$ in the largest dimension, hyaline to yellowish; HYPHAE OF THE ENDOPERIDIUM $\leq 10 \mu\text{m}$ wide, yellowish to pale brown, thick-walled to solid, the ones forming the hyphal fascicles of the surface are tortuous, tightly interwoven with other hyphal elements (mycosclerids).

HABITAT—growing solitary or in small groups (four or five basidiomata) on forest soil (litter), without forming a subiculum.

DISTRIBUTION—known from Honduras and tropical and subtropical areas of Brazil. It is very likely that the species occurs throughout the Neotropical rainforests and warmer regions of temperate America.

SPECIMENS EXAMINED—**HONDURAS**. ATLANTIDA, Tela, 20.III.1923, leg. O.A. Reinking (BPI 705664, holotype!). **BRAZIL**. PERNAMBUCO, São Vicente Férrer, Mata do Estado, 18.IX.2008, leg. L. Trierveiler-Pereira & Baltazar LTP180 (URM 82017, as *G. lloydianum*; ICN 177060); RIO GRANDE DO SUL, São Leopoldo, leg. J. Rick (BPI 705665); 1933, leg. J. Rick (PACA 15976, as *G. berkeleyi*); Caçapava do Sul, Parque Municipal Pedra do Segredo, 6.VI.2011, leg. L. Trierveiler-Pereira LTP277 (ICN 175626); PARANÁ, Foz do Iguaçu, Parque Nacional do Iguaçu, Trilha das Bananeiras, 9.II.2011, leg. L. Trierveiler-Pereira LTP179 (ICN 177057).

ADDITIONAL SPECIMENS EXAMINED—*Geastrum glaucescens*: ARGENTINA. BUENOS AIRES, La Plata, IX.1894, leg. C. Spegazzini (LPS 15860, holotype).

Geastrum hariotii: BRAZIL. C.G. Lloyd's Collection cat. No. 52535 (BPI 841469, holotype).

Geastrum lloydianum: BRAZIL. Leg. J. Rick, C.G. Lloyd's Collection cat. No. 57279 (BPI 841471, holotype).

Geastrum setiferum: BRAZIL. PERNAMBUCO, Serra Negra, 28.V.2002, leg. I.G. Baseia (URM 77077, paratype); PARAÍBA, Mataraca, Mineradora Millenium (Cristal), mata controle, 2.IX.2009, leg. L. Trierveiler-Pereira (URM 82118).

COMMENTS—*Geastrum reinkingii* is characterized by medium-sized basidioma, arched exoperidium; usually not persistent mycelial and fleshy layer; subglobose to ellipsoid, stalked endoperidium, with dark, asperulate to rough endoperidial surface, and a whitish apophysis.

The endoperidial stalk and the apophysis are not clearly evident when the endoperidium is recently exposed, but both are remarkable features in dried collections. Some herbarium specimens exhibit a whitish pruina on the endoperidial surface. The basidiospores are typically dark brown and with discrete ornamentation. Immature forms were not found in herbarium collections or in the field, therefore basidia morphology remains unknown. Brazilian specimens show no major differences from the holotype, the whitish

apophysis and short-stalked blackish depressed globose endoperidium being the most remarkable features. Basidiospore measurements and morphology are constant among the examined specimens.

One *G. reinkingii* collection from Southern Brazil, sent by Rick to Lloyd, is at BPI (705665), but no collections were deposited at PACA, Rick's most important fungal collection. However, one of Rick's collections identified as *G. berkeleyi* (PACA 15976) does correspond to *G. reinkingii*. One *G. reinkingii* specimen (URM 82017) was reported from Northeastern Brazil as *G. lloydianum* (Trierveiler-Pereira et al. 2011).

Geastrum hariatii and *G. lloydianum* are very closely related species, and their differences have been discussed by Trierveiler-Pereira & Silveira (2012). Microscopically, the differences separating *G. reinkingii* and *G. lloydianum* are evident, since the *G. lloydianum* basidiospores are 5–6 µm in diam., yellowish brown, and prominently ornamented. Since there are a limited number of morphological characters available to differentiate species of *Geastrum*, we still believe that basidiospore morphology is an important diagnostic feature. The *G. hariatii* basidiospores are more similar to those of *G. reinkingii*; nonetheless, the two species are macroscopically distinct: *G. hariatii* produces smaller basidiomata with a globose sessile, not asperulate, endoperidium. Moreover, no whitish apophysis is observed in *G. hariatii*.

Geastrum setiferum Baseia produces large arched basidiomata and a short stalked endoperidium (Baseia & Milanez 2002, Trierveiler-Pereira et al. 2011). In many aspects it resembles *G. reinkingii*, but the presence of dark setae in the *G. setiferum* endoperidium is an important distinguishing feature. Moreover, the endoperidial surface of *G. setiferum* is lighter (usually light brown), not remarkably ellipsoidal, without a whitish apophysis, and the peristome morphology is a transition between fibrillose and plicate.

Geastrum glaucescens Speg. was described from Argentina and its basidiomes are small, arched, and dark colored. The endoperidium is globose, brownish to blackish, and covered with abundant persistent white mesoperidial matter (Kuhar et al. 2013). According to the protologue, the endoperidium is short stalked (Spegazzini 1912), but this feature was difficult to confirm by analysis of the type specimen, which is sectioned in half. Soto & Wright (2000) illustrated the species as clearly stalked. The primary macroscopical features distinguish this species from *G. reinkingii*, as depicted by Kuhar et al. (2012).

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